General

Guideline Title

ACR Appropriateness Criteria® limping child — ages 0-5 years.

Bibliographic Source(s)

Milla SS, Coley BD, Karmazyn B, Dempsey-Robertson ME, Dillman JR, Dory CE, Garber M, Hayes LL, Keller MS, Meyer JS, Paidas C, Raske ME, Rigsby CK, Spottswood S, Strouse PJ, Widmann RF, Wootton-Gorges SL, Expert Panel on Pediatric Imaging. ACR Appropriateness CriteriaÂ® limping child - ages 0-5 years. [online publication]. Reston (VA): American College of Radiology (ACR); 2012. 9 p. [77 references]

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Fordham L, Gunderman R, Blatt ER, Bulas D, Coley BD, Podberesky DJ, Prince JS, Tosi L, Expert Panel on Pediatric Imaging. Limping child--ages 0-5 years. [online publication]. Reston (VA): American College of Radiology (ACR); 2007. 5 p. [59 references]

Recommendations

Major Recommendations

ACR Appropriateness Criteria®

Clinical Condition: Limping Child--Ages 0-5 Years

Variant 1: Nonlocalizable pathology by clinical evaluation (no concern for infection).

Radiologic Procedure	Rating	Comments	RRL*
X-ray lower leg	8	Tibia/fibula only.	
US hip	6	Toxic synovitis and septic arthritis usually present with localizing symptoms.	O
X-ray pelvis and leg and foot	5	May be considered as secondary investigation after negative tibia/fibula examination.	

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate.

X-ray lumbar spine — Frontal and lateral views.

*Relative

Radiologic Procedure	Rating	Comments	RRL*
Tc-99m 3-phase bone scan lower thoracic spine to distal lower extremities	5		
MRI lower thoracic spine to lower extremities without contrast	5	Superior to bone scan for soft-tissue pathology. Data for contrast administration in this scenario are limited. Sedation risks should be considered.	O
MRI lower thoracic spine to lower extremities without and with contrast	5	Superior to bone scan for soft-tissue pathology. Data for contrast administration in this scenario is limited. Use contrast if needed based on evaluation of noncontrast MRI findings. Sedation risks should be considered. See statement regarding contrast in text under "Anticipated Exceptions."	O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 2: Localized pathology by clinical evaluation (no concern for infection).

Radiologic Procedure	Rating	Comments	RRL*
X-ray area of interest	9		Varies
MRI area of interest without contrast	6	Sedation risks should be considered.	O
MRI area of interest without and with contrast	6	Use contrast if needed based on evaluation of noncontrast MRI findings. Sedation risks should be considered. See statement regarding contrast in text under "Anticipated Exceptions."	O
US area of interest	5	Consider for palpable soft-tissue mass or suspected joint effusion. Provides only limited data for evaluation of osseous abnormalities.	O
CT area of interest without contrast	3		Varies
CT area of interest with contrast	2		Varies
CT area of interest without and with contrast	1		Varies
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 3: Concern for infection, including septic arthritis.

Radiologic Procedure	Rating	Comments	RRL*
US hips	9		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation

Radiologic Procedure	Rating	Comments	RRL*
MRI pelvis without contrast	7	Sedation risks should be considered.	O
MRI pelvis without and with contrast	7	Use contrast if needed based on evaluation of noncontrast MRI findings. Sedation risks should be considered. See statement regarding contrast in text under "Anticipated Exceptions."	O
X-ray lumbar spine	5		⬜⬜
Tc-99m 3-phase bone scan area of interest	5	If MRI is not available or contraindicated.	⬜⬜⬜
CT area of interest with contrast	4	If MRI is not available or contraindicated.	Varies
CT area of interest without contrast	2		Varies
CT area of interest without and with contrast	1		Varies
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

<u>Summary of Literature Review</u>

The limping child can be a diagnostic dilemma for clinicians. The role of radiology in the evaluation varies depending on the clinical presentation, signs, and symptoms. In general, the differential diagnosis of limping depends on the patient's age, presence of signs of infection, any localization of pain, and history of trauma. The presence of fever, elevated white blood count, elevated erythrocyte sedimentation rate (ESR) or elevated C-reactive protein may suggest infection. Increased heart rate may be a sign of infection but may also be explained by the presence of pain. The presence of erythema, swelling, or maximal tenderness may help localization. Physical maneuvers and signs such as the Trendelenburg test, Galeazzi sign, Patrick/FABER test, pelvic compression test, or psoas sign may also help localize pain. A detailed analysis of gait can also suggest the diagnosis.

Many articles discussing clinical evaluation and differential diagnoses have been written, with several clinical algorithms proposed; however, there are no prospective studies using imaging algorithms for evaluation of the limping child.

In order to provide clear and helpful recommendations, the radiologic algorithm can be narrowed down by clinical scenarios:

- Scenario 1: Trauma
- Scenario 2: No trauma, no signs of infection
- Scenario 3: Possible presence of infection

Scenario 1: Trauma

The most common etiology of acute limping in children is traumatic injury. Clinical examination and history may allow localization of the pain or injury to a specific area, which can target the radiologic examination. Targeted radiographs in two or three planes of the area of concern are appropriate in this scenario. Unfortunately, particularly in small children, it is common that the pain cannot be accurately localized to one focal area.

Radiographs

In children <4 years of age, it is common for clinicians to order plain radiographs from the pelvis to feet, due to the patient's typical lack of verbalization and the inability to localize symptoms. Radiographs of the lower extremities are often normal, with reports of fracture incidence ranging from 4%-20%. Tibial fractures are one of the most common diagnoses in this scenario. Recently, one study retrospectively evaluated the use of total-extremity radiographs (133 patients) versus tibia films alone (128 patients) in children <4 years of age presenting with non-weight-bearing and nonfocal examination. Of these 261 patients, 36 (14%) had tibial fractures on initial radiographic imaging. The study found one

nontibial fracture (metatarsal) in total-extremity imaging over tibial films, and suggests limited imaging focused to the tibia in patients in this age range with nonfocal clinical examinations. The concept of fracture diagnosis with decreased radiography and improved clinical criteria has been documented even in the broader pediatric age range. Another study utilized logit analysis and statistical modeling to determine that using the most predictive clinical signs and symptoms would avoid 25.8% of lower-extremity radiographs. Another group of researchers found that gross deformity and point tenderness detected 97% of lower-extremity fractures in children 1 to 15 years of age and suggest that, in the absence of these findings, diagnosing a fracture by radiographs is low.

If initial imaging is normal, but symptoms persist, follow-up imaging may be useful. In one study, follow-up radiographs in a portion of patients with continued symptoms yielded four additional missed tibial fractures, shown to be subtle toddler's fractures with interval development of periosteal reaction. One patient who was discharged later returned with worsening symptoms and signs of infection and was found to have spinal diskitis and epidural abscess. As these examples demonstrate, if initial evaluation is negative, follow-up instructions and evaluation may be necessary.

Nuclear Medicine

Radionuclide bone scans have shown some efficacy in evaluating limping children younger than 5 years of age, particularly when the examination is nonfocal. The bone scan provides a total-body screen and is sensitive in detecting bone or soft-tissue abnormality. A group of authors studied patients without radiographic abnormalities of the lower extremities and no history of fever or infection, child abuse, or malignancy, and found that 30 out of 56 patients had abnormal bone scans, with the dominant finding of tarsal uptake (16 patients) thought to be due to stress injury. Another group of researchers studied a group of 50 children and showed similar findings of localization of abnormal uptake in 54% of patients. It is rare for bone scan to be the first study in a child with trauma. There are instances where bone scintigraphy may be helpful in detecting injury, particularly in nonverbal neurodevelopmentally delayed children. Toddler's fractures are well visualized by bone scan; however, given the additional cost and radiation exposure, this is not usually the preferred modality of diagnosing toddler's fractures.

Computed Tomography

The role of computed tomography (CT) is limited in the early workup of a child with a limp, due to the ionizing radiation and the efficacy of other imaging modalities. It can be useful in preoperative evaluation of known fractures, in diagnosing osteoid osteoma, and in detecting osteopenia in early tibial stress fractures.

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) is a costly examination and, in this age range, often requires sedation due to the length of the examination. MRI is sensitive for soft-tissue and bony injury, with particular use in detection of stress fractures. It may be performed in selected younger children, when complications, alternate diagnoses, or subtle injuries need to be diagnosed or excluded.

Scenario 2: No Trauma, No Signs of Infection

In this scenario, patients may be presenting with nonacute development of limping or possibly unwitnessed acute trauma. The differential diagnosis in this scenario is broader and encompasses other entities such as toxic synovitis, Legg-Calve-Perthes (LCP) disease, juvenile idiopathic arthritis, developmental dysplasia of the hip (DDH), child abuse, and neoplasm.

Transient synovitis of the hip, also known as toxic synovitis, affects approximately 3% of children, typically during the ages of 3-10 years. Although the etiology is not completely elucidated, many of the children who present with transient synovitis will have had an upper respiratory illness in the preceding 2 weeks, suggesting an inflammatory postviral response. Nearly all children recover with rest and anti-inflammatory medication within 2 weeks. In one prospective study of 243 children under 14 years of age presenting with an atraumatic limp, the most common diagnosis was transient synovitis. Radiographs may demonstrate subtle signs of toxic synovitis, such as hip joint space widening, loss of soft-tissue planes around the hip joint, or slight demineralization of the bone of the proximal femoral metaphysis. However, the sensitivity and specificity of radiographs for this diagnosis are low. Making an accurate and specific diagnosis based on a bone scan may be difficult, as the scan may show decreased uptake early in the disease process and increased uptake later due to hyperemic response.

Ultrasound (US) of the hip is a fast, radiation-free examination that has high sensitivity for detecting hip effusions. Given the frequency of diagnosis, one study routinely uses US as the primary imaging modality, reserving radiographs for cases where the US was negative. Another study also suggests US as the primary imaging technique in transient synovitis, with radiography being unnecessary in uncomplicated cases. False negatives can occur with US, with a reported rate of 5%, due to inadequate examinations or very early scanning. One study showed that radionuclide bone scan in the irritable hip workup had limited diagnostic value when findings on US were negative. As transient synovitis may have overlap clinically with septic arthritis, laboratory values and fluid aspiration are key in differentiating the two entities. MRI has been shown to be helpful in differentiating transient synovitis from septic arthritis.

LCP is an idiopathic avascular necrosis of the proximal femoral epiphysis. LCP is a rare condition affecting 0.005%-0.016% of the population,

with a predisposition towards boys (5:1). It is typically diagnosed between 2-14 years of age, with peak incidence at 5-6 years of age. Typically unilateral, LCP can occur in both hips in 15% of patients. Evaluation traditionally begins with radiographs (anteroposterior [AP] and frog leg lateral positions). Early in the disease process, subcortical lucency may be seen, with progression to femoral head cortical collapse, fragmentation, sclerosis, and widening and shortening of the femoral head/neck.

There are definite roles for contrast-enhanced MRI and/or bone scintigraphy, particularly in the classification and outcome prediction in patients with Langerhans cell histiocytosis (LCH). Postcontrast MRI can show its avascular appearance within the proximal femoral epiphysis and better delineates its extent and severity to allow a more accurate prognosis.

Juvenile idiopathic arthritis (JIA) is a diagnosis that applies to any arthritis of unknown origin that occurs before the age of 16 years and persists for more than 6 weeks. The classification of JIA is recent (2000) and encompasses many subgroups (and previous classifications) of arthritides, including juvenile chronic arthritis and juvenile rheumatoid arthritis. Its overall incidence is not well reported; however, it is thought to be a rare cause of limping in children, and can present even in the preschool years. Initial radiographs can be normal or show minor nonspecific changes such as soft-tissue swelling, joint effusion, or osteopenia. Progressive radiographic changes such as joint space narrowing, erosive changes, and joint ankylosis are seen later in the disease course. US has been shown to be an excellent tool in the evaluation and follow-up of JIA and more sensitive than radiography or clinical examination in detecting effusions, synovial hypertrophy, and synovial cysts. MRI is superior to both US and radiography in detecting inflammatory changes in the joint and cartilage damage. Subtle erosions, loss of joint space, cartilage damage, and ligamentous involvement are also better detected and delineated with MRI. While US and MRI are the best modalities for detection and follow-up of JIA, limited use of bone scan is reported. Actively inflamed joints can be demonstrated. However, increased uptake is also seen in normal growth plates, which may be very close to the adjacent joints, thus limiting the evaluation.

DDH is often diagnosed within the first year of life by physical examination and/or by radiologic screening in predisposed populations. Specific American College of Radiology (ACR) Appropriateness Criteria® have been constructed for this scenario (see the National Guideline Clearinghouse [NGC] summary ACR Appropriateness Criteria® Developmental Dysplasia of the Hip — Child). If clinical history suggests undiagnosed DDH in the older infant or child, AP radiograph of the hips will confirm the diagnosis.

Child abuse should be considered a possibility if soft-tissue or skeletal injuries are identified without the appropriate traumatic clinical history. As this is an extremely important topic, separate ACR Appropriateness Criteria® have been constructed for guidance in imaging (see the NGC summary ACR Appropriateness Criteria® Suspected Physical Abuse — Child).

Neoplasm may present in scenario 2 or 3 and is discussed below.

Scenario 3: Possible Infection

Limping in the presence of one or more of the following clinical/laboratory signs should suggest the possibility of infection: fever, elevated white blood count, elevated ESR, or elevated C-reactive protein. The differential diagnoses in this scenario most commonly include septic arthritis, transient synovitis, osteomyelitis, diskitis, and psoas abscess. Neoplastic entities, such as leukemia, osteosarcoma, Ewing's sarcoma, LCH, and osseous metastatic disease may present in either scenario 2 or 3.

Septic arthritis is the most common cause of acute severe monoarticular pain in children. It typically results from hematogenous and subsequent intra-articular *Staphylococcus aureus*, with the hip being the most common site of involvement. Septic arthritis requires rapid diagnosis to prevent or limit adverse outcomes.

Osteomyelitis is most common in young children, peaking around 3 years of age, with approximately half of the cases occurring in children <5 years of age. Hematogenous spread of disease is the most common source, and *Staphylococcus aureus* is the most common organism isolated. One-third of children presenting with osteomyelitis will have a history of recent trauma at the site, and involvement is most common at the metaphyseal region of the long bones of the lower extremities.

Diskitis is a rare inflammatory and/or infectious process of the intervertebral disc, which may involve the adjacent vertebral bodies (osteomyelitis) and may extend into the adjacent soft-tissues and epidural space. An incidence of 1/100,000 is reported with a bimodal distribution, with a peak incidence at ages 1–4 years and less commonly at 10–14 years. A recent study and review of cases suggests it can be a difficult diagnosis to make, particularly because of the lack of early radiographic and definitive bone scan findings.

Neoplasm should be included in the differential diagnosis, as the laboratory findings and presentation may overlap with osteomyelitis. Diffuse marrow abnormalities may suggest leukemia or metastatic disease, particularly in neuroblastoma. Soft-tissue masses and associated calcification should raise concern for osteosarcoma and Ewing's sarcoma, although they are less common in the 1-5-year-old population.

LCH is an aggressive marrow-replacing histiocytic disorder thought to be either inflammatory or neoplastic, with a reported incidence of 8-9/1 million. Involvement can be at a single site or can involve multiple organs. Imaging appearance may be benign, as with a well-circumscribed lytic

lesion, or can be aggressive with associated soft-tissue mass, overlapping in appearance with osteomyelitis and tumor.

Myositis and soft-tissue abscesses are less common but have been reported in all ages of children, including infants and toddlers, but the largest clustering in children appears to be in children 6-17 years of age.

Given the spectrum of these differential diagnoses, imaging guidelines can be further classified by the clinical examination: localized pain (hip or nonhip) or nonlocalizable pain.

Scenario 3A: Localized Pain to the Hip

Localization is important in the radiologic evaluation of the patient. If the pain appears localized to the hip, the diagnosis of exclusion is septic arthritis. As mentioned in the transient synovitis discussion above, US of the hip allows the quick and accurate diagnosis of a joint effusion. Aspiration is the gold standard in differentiating septic arthritis from transient synovitis. There are studies that suggest clinical data can help determine which effusions need to be aspirated. The presence of fever, an elevated C-reactive protein level, an elevated ESR, lack of weight-bearing, and an elevated serum white-blood-cell count have been shown to be indicators of septic arthritis, with the presence of several of these factors and documented joint indicated a >90% probability of septic arthritis. However, this clinical protocol has proven less specific in other researchers' studies. MRI of the pelvis in cases of septic arthritis may demonstrate associated osteomyelitis or associated soft-tissue abscess and may be considered following sonography if clinical history suggests a longstanding infection.

In the absence of a hip effusion and with signs of infection and hip localization, a diagnosis of pelvic osteomyelitis or pyomyositis should be considered. One study concluded that plain radiographs of the pelvis may be somewhat useful but their sensitivity for detecting abnormality may be as low as 11%-30%. MRI, given its sensitivity to musculoskeletal injury and inflammation, is extremely useful in diagnosing infection, specifically osteomyelitis and pyomyositis. Findings of infection on MRI include abnormal bone marrow signal, soft-tissue inflammation, abnormal enhancement and intraosseous, subperiosteal, and/or soft-tissue abscess formation. Contrast administration in the MR evaluation of suspected soft-tissue or osseous infection does not increase sensitivity or specificity but may increase reader confidence and better delineate abscesses. As stated earlier, a benefit of MRI is its lack of ionizing radiation; however, the need for sedation in young patients may complicate its use in diagnosis. While bone scan has been shown to detect osteomyelitis in radiographically silent cases, in one study, bone scan was found to have only 70% sensitivity in their 33 patients as compared to MRI. Consequently the study recommends pelvic MRI in pediatric patients with acute hip pain, ESR of >30 mm/h, and no evidence of septic hip.

Scenario 3B: Localized Pain, Nonhip/Lower Extremity

Plain radiographs of the localized area of pain should be obtained. Irregular or mottled lucencies reflect marrow abnormality, and periosteal elevation demonstrates inflammatory reaction and chronicity, as in infection or neoplasm. Soft-tissue mass and calcification without a history of trauma suggest neoplasm. MRI, given its sensitivity to musculoskeletal injury and inflammation, is extremely useful in diagnosing infection, specifically osteomyelitis and pyomyositis. Findings of infection on MRI include abnormal bone marrow signal, soft-tissue inflammation, abnormal enhancement, and intraosseous, subperiosteal and/or soft-tissue abscess formation. Contrast administration in the MR evaluation of suspected soft-tissue or osseous infection does not increase sensitivity or specificity but may increase reader confidence and better delineate abscesses. As stated earlier, a benefit of MRI is the lack of ionizing radiation; however, the need for sedation in young patients may complicate its use in diagnosis. Due to the severity of late diagnosis of infection, the presence of signs and symptoms of infection often outweigh the risks of sedation in this scenario. While bone scan has been reported to have a high sensitivity for the diagnosis of osteomyelitis, MRI has been advocated as the imaging technique of choice for evaluation of pelvic osteomyelitis because of its lack of ionizing radiation and better ability to detect abscesses. While no prospective study of MRI versus bone scan has been performed in this scenario, review of recent literature suggests that MRI is commonly used in the evaluation. A recent retrospective study examining bone scan and MRI demonstrated a much higher sensitivity of MRI (99%) compared to bone scan (53%) and suggested that the imaging algorithm of plain radiographs be followed by MRI. Even after a positive bone scan, MRI is often obtained for further evaluation of soft-tissues to detect any abscess formation.

Scenario 3C: Nonlocalized Pain

In nonlocalizable limping with possible infection, radiographs of the spine, pelvis, and lower extremities may help localize an abnormality. However, low sensitivities have been reported. As stated above, in the acute presentation of osteomyelitis, plain radiographs are typically normal. MRI or bone scan can be considered in this scenario. While there have been no prospective studies comparing MRI and bone scan in the evaluation for osteomyelitis, both imaging techniques have reported high sensitivity for the diagnosis. Positives for performing MRI include lack of ionizing radiation and better resolution and soft-tissue evaluation, with the dominant negative being the need for sedation in this age group. Contrast administration during MRI has not been shown to be necessary in the evaluation for soft-tissue or osseous infection, particularly in the absence of signs of edema. Positives for bone scan include cost-effective diagnosis and whole-body imaging for site localization, with the dominant negative being the lack of soft-tissue detail and abscess detection and slightly decreased sensitivity. As stated above, review of the literature suggests that more centers may be using MRI in the evaluation for osteomyelitis; however, no prospective study has fully evaluated the scenario of a limping

child without a localizable site.

Fluorine-18-2-fluoro-2-deoxy-D-glucose positron emission tomography (FDG-PET) imaging and leukocyte scintigraphy can be useful in evaluating chronic osteomyelitis, outperforming MRI and radiographs as was demonstrated in one study. Whole-body MRI may also be helpful in children with multifocal abnormalities.

Summary

- The type of imaging evaluation to be used for a limping child can be determined after a thorough clinical evaluation. Eliciting a history of trauma and/or signs of infection can help focus the imaging pathway to diagnosis.
- Imaging pathways for the above-described three scenarios (trauma, no trauma/no signs of infection, and possible presence of infection) vary due to the diverse differential diagnoses in these subgroups.
- In a post-traumatic setting, localized radiographs or tibial radiographs are most appropriate.
- In an atraumatic and noninfectious history, hip US may be the initial study of choice, with radiography to follow if the US finding is negative. If there is a suggestion of infection, MRI is the study of choice, with radiography a low-sensitivity but commonly obtained initial imaging modality. Bone scan may also be considered in this setting, particularly if the site of tenderness or pain cannot be determined.

Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (i.e., <30 mL/min/1.73 m^2), and almost never in other patients. There is growing literature regarding NSF. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73 m^2. For more information, please see the ACR Manual on Contrast Media (see the "Availability of Companion Documents" field).

Abbreviations

- CT, computed tomography
- MRI, magnetic resonance imaging
- Tc, technetium
- US, ultrasound

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
	<0.1 mSv	<0.03 mSv
	0.1-1 mSv	0.03-0.3 mSv
	1-10 mSv	0.3-3 mSv
	10-30 mSv	3-10 mSv
	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."		

Clinical Algorithm(s)

Algorithms were not developed from criteria guidelines.

Scope

Disease/Condition(s)

Limping child

Guideline Category

Diagnosis

Evaluation

Clinical Specialty

Emergency Medicine

Family Practice

Infectious Diseases

Neurology

Nuclear Medicine

Orthopedic Surgery

Pediatrics

Radiology

Intended Users

Health Plans

Hospitals

Managed Care Organizations

Physician Assistants

Physicians

Utilization Management

Guideline Objective(s)

To evaluate the appropriateness of initial radiologic examinations for the limping child

Target Population

The limping child age 0-5 years

Interventions and Practices Considered

1. X-ray
   - Lower leg
   - Pelvis
   - Pelvis and leg and foot
   - Lumbar spine
   - Area of interest
2. Computed tomography (CT) area of interest
   - With contrast
   - Without contrast
   - Without and with contrast
3. Magnetic resonance imaging (MRI)
   - Lower thoracic spine to lower extremities without contrast
   - Lower thoracic spine to lower extremities without and with contrast
   - Pelvis without contrast
   - Pelvis without and with contrast
   - Area of interest without contrast
   - Area of interest without and with contrast
4. Ultrasound (US)
   - Hip
   - Area of interest
5. Technetium (Tc)-99m 3-phase bone scan
   - Lower thoracic spine to distal lower extremities
   - Area of interest

Major Outcomes Considered

Utility of radiologic examinations in differential diagnosis

Methodology

Methods Used to Collect/Select the Evidence

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Literature Search Procedure

The Medline literature search is based on keywords provided by the topic author. The two general classes of keywords are those related to the condition (e.g., ankle pain, fever) and those that describe the diagnostic or therapeutic intervention of interest (e.g., mammography, MRI).

The search terms and parameters are manipulated to produce the most relevant, current evidence to address the American College of Radiology Appropriateness Criteria (ACR AC) topic being reviewed or developed. Combining the clinical conditions and diagnostic modalities or therapeutic procedures narrows the search to be relevant to the topic. Exploding the term "diagnostic imaging" captures relevant results for diagnostic topics.

The following criteria/limits are used in the searches.

1. Articles that have abstracts available and are concerned with humans.
2. Restrict the search to the year prior to the last topic update or in some cases the author of the topic may specify which year range to use in the search. For new topics, the year range is restricted to the last 5 years unless the topic author provides other instructions.
3. May restrict the search to Adults only or Pediatrics only.
4. Articles consisting of only summaries or case reports are often excluded from final results.

The search strategy may be revised to improve the output as needed.

Number of Source Documents

The total number of source documents identified as the result of the literature search is not known.

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Strength of Evidence Key

Category 1 - The conclusions of the study are valid and strongly supported by study design, analysis and results.

Category 2 - The conclusions of the study are likely valid, but study design does not permit certainty.

Category 3 - The conclusions of the study may be valid but the evidence supporting the conclusions is inconclusive or equivocal.

Category 4 - The conclusions of the study may not be valid because the evidence may not be reliable given the study design or analysis.

Methods Used to Analyze the Evidence

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

The topic author drafts or revises the narrative text summarizing the evidence found in the literature. American College of Radiology (ACR) staff draft an evidence table based on the analysis of the selected literature. These tables rate the strength of the evidence for all articles included in the narrative text.

The expert panel reviews the narrative text, evidence table, and the supporting literature for each of the topic-variant combinations and assigns an appropriateness rating for each procedure listed in the table. Each individual panel member forms his/her own opinion based on his/her interpretation of the available evidence.

More information about the evidence table development process can be found in the ACR Appropriateness Criteria® Evidence Table Development document (see the "Availability of Companion Documents" field).

Methods Used to Formulate the Recommendations

Expert Consensus (Delphi)

Description of Methods Used to Formulate the Recommendations

Modified Delphi Technique

The appropriateness ratings for each of the procedures included in the Appropriateness Criteria topics are determined using a modified Delphi methodology. A series of surveys are conducted to elicit each panelist's expert interpretation of the evidence, based on the available data, regarding the appropriateness of an imaging or therapeutic procedure for a specific clinical scenario. American College of Radiology (ACR) staff distributes surveys to the panelists along with the evidence table and narrative. Each panelist interprets the available evidence and rates each procedure. The surveys are completed by panelists without consulting other panelists. The ratings are a scale between 1 and 9, which is further divided into three categories: 1, 2, or 3 is defined as "usually not appropriate"; 4, 5, or 6 is defined as "may be appropriate"; and 7, 8, or 9 is

defined as "usually appropriate." Each panel member assigns one rating for each procedure per survey round. The surveys are collected and the results are tabulated, de-identified and redistributed after each round. A maximum of three rounds are conducted. The modified Delphi technique enables each panelist to express individual interpretations of the evidence and his or her expert opinion without excessive bias from fellow panelists in a simple, standardized and economical process.

Consensus among the panel members must be achieved to determine the final rating for each procedure. Consensus is defined as eighty percent (80%) agreement within a rating category. The final rating is determined by the median of all the ratings once consensus has been reached. Up to three rating rounds are conducted to achieve consensus.

If consensus is not reached, the panel is convened by conference call. The strengths and weaknesses of each imaging procedure that has not reached consensus are discussed and a final rating is proposed. If the panelists on the call agree, the rating is accepted as the panel's consensus. The document is circulated to all the panelists to make the final determination. If consensus cannot be reached on the call or when the document is circulated, "No consensus" appears in the rating column and the reasons for this decision are added to the comment sections.

Rating Scheme for the Strength of the Recommendations

Not applicable

Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

Method of Guideline Validation

Internal Peer Review

Description of Method of Guideline Validation

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria.

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The recommendations are based on analysis of the current literature and expert panel consensus.

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

Selection of appropriate radiologic imaging procedures for diagnosis and evaluation of the limping child

Potential Harms

- False negatives can occur with ultrasound (US), with a reported rate of 5%, due to inadequate examinations or very early scanning.
- Magnetic resonance imaging (MRI) is a costly examination and, in this age range, often requires sedation due to the length of the examination.

Gadolinium-based Contrast Agents

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (i.e., <30 mL/min/1.73 m^2), and almost never in other patients. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73 m^2. For more information, please see the American College of Radiology (ACR) Manual on Contrast Media (see the "Availability of Companion Documents" field).

Relative Radiation Level (RRL)

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults. Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document (see the "Availability of Companion Documents" field).

Qualifying Statements

Qualifying Statements

An American College of Radiology (ACR) Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists, and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the U.S. Food and Drug Administration (FDA) have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

IOM Domain

Identifying Information and Availability

Bibliographic Source(s)

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

1995 (revised 2012)

Guideline Developer(s)

American College of Radiology - Medical Specialty Society

Source(s) of Funding

The American College of Radiology (ACR) provided the funding and the resources for these ACR Appropriateness Criteria®.

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Committee on Appropriateness Criteria, Expert Panel on Pediatric Imaging

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Financial Disclosures/Conflicts of Interest

Not stated

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Fordham L, Gunderman R, Blatt ER, Bulas D, Coley BD, Podberesky DJ, Prince JS, Tosi L, Expert Panel on Pediatric Imaging. Limping child--ages 0-5 years. [online publication]. Reston (VA): American College of Radiology (ACR); 2007. 5 p. [59 references]

Guideline Availability

Electronic copies: Available from the American College of Radiology (ACR) Web site.

Print copies: Available from the American College of Radiology, 1891 Preston White Drive, Reston, VA 20191. Telephone: (703) 648-8900.

Availability of Companion Documents

The following are available:

- ACR Appropriateness Criteria®. Overview. Reston (VA): American College of Radiology; 2 p. Electronic copies: Available in Portable Document Format (PDF) from the American College of Radiology (ACR) Web site.
- ACR Appropriateness Criteria®. Literature search process. Reston (VA): American College of Radiology; 1 p. Electronic copies: Available in Portable Document Format (PDF) from the ACR Web site.
- ACR Appropriateness Criteria®. Evidence table development – diagnostic studies. Reston (VA): American College of Radiology; 2013 Nov. 3 p. Electronic copies: Available in PDF from the ACR Web site.
- ACR Appropriateness Criteria®. Radiation dose assessment introduction. Reston (VA): American College of Radiology; 2 p. Electronic copies: Available in Portable Document Format (PDF) from the ACR Web site.
- ACR Appropriateness Criteria® Manual on contrast media. Reston (VA): American College of Radiology; 92 p. Electronic copies: Available in PDF from the ACR Web site.
- ACR Appropriateness Criteria®. Procedure information. Reston (VA): American College of Radiology; 1 p. Electronic copies: Available in PDF from the ACR Web site.
- ACR Appropriateness Criteria® limping child-ages 0-5 years. Evidence table. Reston (VA): American College of Radiology; 28 p. Electronic copies: Available from the ACR Web site.

Patient Resources

None available

NGC Status

This NGC summary was completed by ECRI Institute on December 20, 2007. This summary was updated by ECRI Institute on January 13, 2011 following the U.S. Food and Drug Administration (FDA) advisory on gadolinium-based contrast agents. This NGC summary was updated by ECRI Institute on September 6, 2012.

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